Development of Learning Modules Using an Ethnoscience-Based Project-Based Learning Model to Enhance Students' Collaboration, Critical Reasoning, and Creativity

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Abstract

The Ministry of Education, Culture, Research, and Technology emphasizes the improvement of students' character through various strategies focused on creating Pancasila Students. The main challenges at SDN Manyaran 2 include low collaboration among students and the need to improve critical and creative thinking skills. The study aims to develop, test feasibility, and evaluate the effectiveness of a Project-based Learning module based on Ethnoscience on Light and its properties for fifth-grade students, focusing on improving cooperative skills, critical reasoning, and creativity. This research follows the ADDIE development model, which includes analysis, design, development, implementation, and evaluation stages. Data collection methods include interviews, questionnaires, observation, documentation, and tests. This research was conducted in the fifth grade at SDN Manyaran 2 in Semarang, involving 28 students. The results showed that the development of the learning module was deemed highly feasible, with validation scores for media, content, and language and responses from teachers and students reaching 100%. The product's effectiveness improved students' collaboration, critical reasoning, and creativity. The research results offer students a rewarding and meaningful learning experience, encouraging their ongoing growth and learning motivation. Thus, using a learning module with Project-based Learning Based on Ethnoscience received a highly feasible validation and positively impacted enhancing students' collaboration, critical reasoning, and creativity.

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INTRODUCTION

In the context of the Merdeka Curriculum, the Minister of Education, Culture, Research, and Technology of the Republic of Indonesia, Nadiem Anwar Makarim, stated that the Ministry will realize the improvement of student's character through various strategies focused on creating Pancasila Students (Ismail et al., 2021). This Pancasila Student profile reflects the desired character and competencies expected from students (Mery et al., 2022). Another aim of the Pancasila Student profile is to empower students with the noble values of Pancasila (Kemendikbudristek, 2022). The Pancasila Student profile includes attributes such as faith in God Almighty and noble character, global diversity, collaboration, independence, critical reasoning, and creativity (Irawati et al., 2022; Kurniawaty et al., 2022; Mery et al., 2022).

Technological advancements should utilized effectively, if not it will the impact will result in the emergence of a younger generation tending toward individualistic tendencies (Amelia & Ramadan, 2021; Hayati & Utomo, 2022; Putri et al., 2022). This phenomenon contradicts the principle of collaboration, which is part of the profile of Pancasila students. Collaboration is interpreted as activities or actions done together without expecting rewards to achieve the common good (Kurniawati & Mawardi, 2021). The low spirit of collaboration may be caused by the lack of group activities in tasks and learning activities organized by teachers (Milah Akmaliah et al., 2022; Mustaghfiroh & Listyaningsih, 2022; Puspita & Setyaningtyas, 2022). The situation is also experienced by fifth-grade students at SDN Manyaran 02, Semarang City.

Based on the interview and observations in the fifth-grade class at SDN Manyaran 2, the researcher found that teachers rarely organize learning activities supporting collaboration among students. Consequently, both tasks and learning tend to be more individualistic. According to the teachers, group activities and discussions are considered less effective because they require considerable time. Teachers prefer to deliver lessons using conventional methods to students.

In 2015, the average Science in Level 4 (primary school age) score from Indonesia's participation in the Trends in International Mathematics and Science Study (TIMSS) was 397, ranking 51st out of 54 participating countries. Indonesia was placed fourth from the bottom, above Kuwait, Monaco, and Saudi Arabia (Provasnik). These data illustrate that Indonesian students' achievements are still significantly below the international average performance, consistent with the findings of Sarwi & Subali (2019). The TIMSS assessment data indicates that the science learning achievement of Indonesian students is relatively low (Wijanarko et al., 2017). Gandi et al. (2021), noted that TIMSS questions can indicate students' critical thinking skills. Idris (2020), also emphasizes that aspects of understanding, application, and reasoning in the cognitive domain, as measured by TIMSS, can demonstrate the profile of students' critical thinking abilities. Based on these findings, it can be concluded that the essential thinking skills of Indonesian students are still low. This finding is consistent with several studies, such as Amran et al. (2022), Bahtiar et al. (2022), Benyamin et al. (2021), Hidayat (2021), dan Rizza (2020), stated that there are still students with low critical thinking skills. This situation reflects the low profile of critical reasoning, one of the aspects in the profile of Pancasila students.

The lack of critical thinking skills in students is caused by several factors, including (1) inadequate understanding of the problems by students; (2) students easily forgetting the taught material; (3) students' difficulty in connecting concepts with real-life situations; (4) lack of focus and students' tendency to easily get bored during learning; (5) non-contextualized learning implementations (Ardianti et al., 2020; Benyamin et al., 2021; Fuadi et al., 2020; Pratiwi & Setyaningtyas, 2020; Simatupang et al., 2020).

Critical thinking involves mental activities, including analyzing assumptions, generating biological questions, and decision-making (Fuadi et al., 2020). Students with good critical thinking

skills can carefully evaluate whether a statement is true or false. Developing critical thinking skills involves integrating several aspects, such as observation, analysis, reasoning, evaluation, decision-making, and persuasion. Students' level of development of these skills correlates positively with their ability to solve complex problems with satisfactory outcomes. To enhance students' critical thinking skills, a learning model is needed to stimulate them to address the issues they face.

The findings of interviews and observations reveal that the teaching methods commonly employed by teachers are still insufficiently effective in enhancing students' critical thinking skills. Teachers are more focused on addressing students' deficiencies caused by the impacts of the previous pandemic. Therefore, teachers rarely implement teaching methods that encourage students to tackle problems.

TIMSS also indicates the profile of Pancasila students, namely that the creative thinking skills of students in Indonesia are currently still relatively low (Anggraini et al., 2022). In line with TIMSS result, several studies addressing the level of student's creative thinking skills have concluded that there are still students who have low levels of creative thinking abilities ('Adiilah & Haryanti, 2023; Amirulloh et al., 2020; Fahmi & Jumadi, 2023; Sumarni & Kadarwati, 2020).

Students' inability to express their creativity is triggered by the fact that in some primary schools, students' creative thinking abilities have not received sufficient attention. This situation is influenced by teachers' teaching methods, which are generally lecture-oriented, causing students to be less able to develop creativity in problem-solving. An inefficient teaching and learning process also contributes to students' inability to hone their creative thinking skills. This condition arises due to teachers' continued use of conventional learning models. Consequently, students' creativity levels decline, impacting their passive attitudes towards the learning process. Students tend to be reluctant to ask questions and engage in discussions related to learning materials ('Adiilah & Haryanti, 2023;

Arisandy et al., 2021; Sari & Hermawati, 2020; Siregar et al., 2020).

Creativity is the capacity of an individual to discover and create something new, whether it be ideas, methods, or models that benefit themselves or society (Astuti & Aziz, 2019). What is produced does not have to be entirely new but may contain elements that have existed before. An individual can combine pre-existing aspects in new ways and possess different qualities. Meanwhile, Debeturu & Wijayaningsih (2019), define creativity as the ability of an individual to create works through the combination of ideas, concepts, and imagination from various sources. To develop students' creativity, a learning model is needed to encourage them to enhance their creativity.

Based on the interview and observation results in the fifth-grade class at SDN Manyaran 2, the author found that the teaching methods commonly employed by teachers are still not optimal in stimulating students' creativity, especially regarding the topic of Light and its properties. The low level of students' creativity also affects their participation in learning, where they tend to be passive and rarely ask questions about the material. This is due to teachers' use of conventional teaching models. Teachers are more focused on efforts to address students' deficiencies caused by the impacts of the previous pandemic. Therefore, teachers have not implemented a learning model that can encourage students to be more creative in the learning process.

One of the learning models that can enhance students' creativity is Project-Based Learning (PjBL) (Christian, 2021; Kusadi et al., 2020). PjBL is a learning model that uses projects (activities) as the core of learning. In these activities, students explore, assess, interpret, and synthesize information to obtain various learning outcomes (knowledge, skills, and attitudes). The characteristics of project-based learning models always begin with identifying the fundamental questions, which will later serve as the basis for assigning project tasks to students (conducting activities) (Nurjanah et al., 2021). The PjBL model is a recommended learning model in the independent curriculum.

Teachers must connect learning materials with students' daily lives in the independent curriculum. One strategy to present contextual material closely related to students' daily lives is through Ethnoscience. Ethnoscience, according to Lidi et al. (2022), is a learning approach that utilizes local knowledge as a source/object of learning that can be integrated into contextualized learning. The use of ethnoscience in learning can also enhance students' creativity (Rahman et al., 2023; Wanggi et al., 2023). Learning that presents real-life objects as learning materials consistent with students' daily lives is one characteristic of Science learning. One of the subjects in Science learning is Light and its properties. Teaching materials are needed in science learning to facilitate students' learning process.

Based on the interviews and observations conducted by the author at SDN Manyaran 2, fifth-grade class, it was found that the use of teaching materials in science learning at the school is still limited. Teachers only utilize available teaching materials, resulting in a shortage of relevant learning resources. This is due to time constraints, preventing teachers from developing teaching materials to support learning. According to Kosasih (2013), teaching materials are tools teachers or students use to facilitate the learning process. One type of teaching material that can be used is modules. Modules, as described by Kosasih (2013), are printed teaching materials designed for independent study by learners, containing systematically designed content, methods, limitations, and evaluation methods in an interesting manner to achieve the expected competencies according to their level of complexity. The learning modules students use are made of rough paper, resulting in unclear images and blurry text, making it difficult to read.

This research aims to develop a learning module using Ethnoscience-based Project-based Learning that focuses on Light and its properties. It describes the development process, tests its suitability, and examines its effectiveness in enhancing fifth-grade students' skills in collaboration, critical reasoning, and creativity.

The research results offer students a rewarding and meaningful learning experience, encouraging their ongoing growth and learning motivation.

METHODS

This study is a Research and Development (R&D) study that adopts the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model (Sugiyono, 2021). The stages of development research using the ADDIE model can be seen in Figure 1.
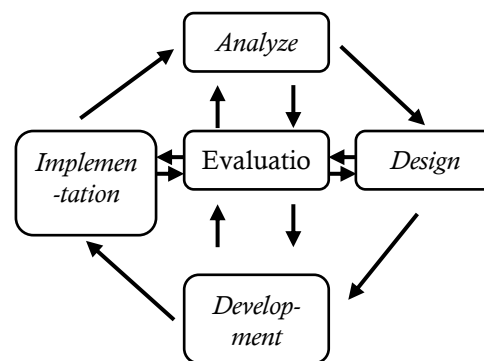

Figure 1. ADDIE Development Model (Tegeh et al., 2014)

This study was conducted at SD N Manyaran 02 in Semarang City. The research subjects consisted of two groups, namely small-scale and large-scale. The small-scale research subjects involved 6 students from class VB of SDN Manyaran 02, Semarang Barat District, Semarang City, selected using the purposive sampling technique, which is a sampling technique based on specific considerations (Sugiyono, 2018). Meanwhile, the large-scale research subjects comprised 28 students from class VA of SDN Manyaran 02, Semarang Barat District, Semarang City.

Data were collected using various techniques, including interviews, questionnaires, observations, documentation, and tests. The instruments used in data collection included interview sheets, observation sheets, documentation sheets, needs assessment questionnaires, validation questionnaires for learning modules, materials, and language, student and teacher response questionnaires,

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questionnaires, and observations for collaboration, questionnaires and skill product assessments for creativity, and evaluation sheets for critical reasoning.

Validation Sheet Analysis

Validation involves assessments from two subject matter experts, media experts and language experts. This validation is carried out to determine the feasibility of the learning module using the project-based learning model based on ethnoscience to enhance collaboration, critical reasoning, and student creativity, with categories presented in Table 1.

Table 1. Assessment Criteria for the Feasibility of Learning Modules (Purwanto, 2016)

Percentage %	Criteria
86-100	Highly Feasible
76-85	Feasible
60-75	Moderately Feasible
<54	Not Feasible

Analysis of Teacher and Student Response Questionnaires

Responses are assessed by 2 fifth-grade teachers and 6 students from class VB who participated in the small-scale trial of using the learning module with the project-based learning model based on ethnoscience to enhance collaboration, critical reasoning, and student creativity, with categories presented in Table 2.

Table 2. Criteria for Percentage Response Results from Teachers and Students for the Feasibility of Learning Modules (Widyoko, 2015)

Percentage %	Criteria
82-100	Highly Feasible
63-81	Feasible
44-62	Moderately Feasible
25-43	Not Feasible

Preliminary Data Analysis

After collecting the data, the next step is to conduct preliminary data analysis. Preliminary data analysis is used before determining differences and average improvements in a study. The preliminary data analysis used is the normality test. The normality test in this study uses the Shapiro-Wilk formula with the assistance of SPSS version 26. The criteria for the normality test can be classified as follows: if the significance value is greater than 0.050, the data is considered normally distributed, whereas if the significance value is less than 0.050, the data is considered not normally distributed.

Final Data Analysis

The final data analysis in this study is divided into testing for mean differences (t-test) and testing for mean improvements (n-gain test). To determine the final data analysis and the effectiveness of the learning module with Project-Based Learning based on ethnoscience to enhance collaboration, critical reasoning, and student creativity, the paired sample t-test can be used with SPSS version 26. The testing criteria are as follows: a significance value (2-tailed) > 0.005 indicates no significant difference between the pretest and posttest, while a significance value (2-tailed) < 0.005 indicates a significant difference.

Gain data determines students' abilities before and after the treatment. Gain index analysis calculates the pretest and posttest results using normalized gain (N-gain). N-gain is comparing the difference between pretest and post-test scores with the difference in Maximum Ideal Score (MIS) on Light and its properties after using the Project-Based Learning module based on ethnoscience. The normalized gain formula can be described in Figure 2. Interpretation criteria for the gain index can be seen in Table 3.

$$\langle g \rangle = \frac{\langle posttest\ score \rangle - \langle pretest\ score \rangle}{MIS - \langle pretest\ score \rangle}$$

Figure 2. Test $\langle g \rangle$

Table 3 Interpretation of Gain Index (Lestari & Yudhanegara, 2017)

$\langle g \rangle$	Criteria
$\langle g \rangle \geq 0{,}70$	Tinggi
$0.30 < \langle g \rangle < 0.70$	Sedang

$\langle g \rangle \leq 0.30$	Rendah

RESULTS AND DISCUSSION

Results and discussions of each stage of the ADDIE model development will be further explained.

Analyze Phase

In the first stage, the needs analysis stage, interviews were conducted with fifth-grade students and teachers at SDN Manyaran 02 in Semarang City. The results of these interviews were then used as a reference in developing the learning module with a project-based learning (PjBL) model based on ethnoscience. Based on interviews with the fifth-grade homeroom teacher, it was found that teachers rarely use comprehensive teaching models, and the learning modules used are limited to government guidelines. Additionally, according to the teacher, teaching methods that can improve student understanding are project-based learning, which is directly carried out by students either individually or in groups, compared to lectures or using only video media. Furthermore, concerning the Pancasila student profile, it was found that students lack collaboration, critical reasoning, and creativity dimensions. Therefore, it can be concluded that fifth-grade teachers have not developed learning modules independently tailored to students' abilities, especially in science subjects.

Design Phase

The planning phase is a continuation of the analysis. In the design of the learning module, a prototype design was created based on the results of the questionnaire analysis of teacher and student needs, as shown below. The main components of the learning module using the project-based learning (PjBL) model based on ethnoscience include the cover, opening page, content page, worksheets, and closing page. The cover contains the title of the learning module, the creator's name, the supervising lecturer, educational logos, the UNNES logo, the class, and the academic year. The opening page contains a preface, table of contents, instructions for using the module, syntax of the project-based learning model, learning achievements, learning objectives, Pancasila student profile, and concept map. The content page contains explanations about ethnoscience in the learning process, properties of Light, and summaries. The worksheets contain work steps according to the project-based learning model and evaluation questions. The selection of the topic "Light and its properties" is tailored to the needs of students at SDN Manyaran 02. The learning strategy adopts the PjBL model based on ethnoscience.

The developed learning module possesses distinctive characteristics and innovations compared to existing learning modules, as follows:

a) The learning model utilized is the project-based learning model based on ethnoscience.

b) It includes the steps of learning activities with the syntax of project-based learning.

c) Learning activities are focused on students (student-centered).

d) The structured learning steps direct students to utilize the cultural environment around them as a learning resource.

e) It incorporates stimuli to enhance cooperative, critical reasoning, and creative abilities.

Development Phase

After the design phase, the process continues with the development phase, which involves realizing the previously made design. In this phase, several tasks need to be accomplished, including:

Development of the Learning Module

The learning module was designed in prototype form and then proceeded to the development stage. The learning module is created using the Canva application. The developed teaching module consists of several

components: cover, preface, table of contents, instructions for using the module, syntax of project-based learning model, learning achievements, learning objectives, Pancasila student profile, concept map, ethnoscience material in the learning process, properties of Light material, summary, student worksheets, evaluation questions, bibliography, author's identity, supervisor's identity, and brief reviews. The developed learning module can be seen in Figure 3.

Figure 3. Design of the Learning Module with Ethnoscience-Based Project-Based Learning

a.Product Validation

The developed product is then validated by experts, including media, content, and language experts, to determine the validity of the developed learning module.

1) Media Validation

Table 4 Media Validation by Media Expert

Indicator	Percentage %	
	Validation I	Validation II
Align with competencies and objectives	100	100
Aligned with the student's developmental level	100	100
Ease of Use	100	100
Appealing visual design.	100	100
Average	100	
Criteria	Highly Feasible	

Two experts are the media expert validators for the developed product. The validation conducted by media experts focuses on the appearance of the learning module. The experts provide assessments by giving comments and suggestions regarding the media to improve and refine the developed learning module. The results of the media validation by media experts are presented in Table 4**.**

2) Material Validation

Table 5 Material Validation by Material Experts

Indicator	Percentage %	
	Validation I	Validation II
Align with competencies and objectives	100	100
The material matches the thinking level.	100	100
Material aligns with media questions.	100	100
Images fit material.	100	100
Average	100	
Criteria	Highly Feasible	

Material experts acting as validators for the developed product involved two experts. The validation focused on the content of the learning module. The experts provided assessments, comments, and suggestions regarding the material to improve and refine the developed learning module. The results of the material validation by material experts can be found in Table 5.

3) Language Validation

Table 6 Language Validation by Language Experts

Indicator	Percentage %	
	Validation I	Validation II
Clear structure.	100	100
Appropriate language.	100	100
Simple sentences.	100	100
Clear communication	100	100
Average	100	
Criteria	Highly Feasible	

Two language experts acted as validators for the developed product. The validation focused on the use of language in the learning module. The experts provided assessments, comments, and suggestions regarding the language used, aiming to improve and refine the learning module. The results of the language validation by the language experts are presented in Table 6.

Implementation Phase

Small Group Trial

After the developed product has passed the validity test and been deemed suitable for testing, the next step is the implementation phase. In the implementation phase, the developed product is applied after necessary adjustments. The learning module using the project-based learning model based on ethnosciences that have been developed is implemented in a real setting in the fifth-grade elementary school class. However, before implementing the learning module in a large group, a trial is conducted in a small group (limited trial) to assess the responses of the fifth-grade teachers and students after the product is tested in the learning process. The small group trial is conducted to observe the practicality level of the learning module.

The limited trial consists of two fifth-grade teachers and six fifth-grade students from SDN Manyaran 02. During the limited trial, teaching and learning activities are conducted as usual based on the learning module using the project-based learning model based on ethnosciences that has been developed. After completing the teaching and learning process, teachers and students are given response questionnaires. The purpose of these questionnaires is to assess the responses of teachers and students to the learning process using the learning module and the project-based learning model based on

ethnosciences that have been developed. The results of the teachers' and students' responses to the learning process using the learning module using the project-based learning model based on ethnosciences are presented in Tables 7 and 8.

Table 7 Teacher Response Results

Indicator	Percentage %	
	Teacher I	Teacher II
Design and Layout	100	100
Ease of Use	100	100
Content and Material Quality	100	100
Average	100	
Criteria	Highly Feasible	

Table 8 Student Response Results

Indicator	Percentage %	
	Yes	No
Design and Layout	100	0
Ease of Use	100	0
Content and Material Quality	100	0
Average	100	
Criteria	Highly Feasible	

Large Group Trial

The large group trial provided instruction using the learning module with the project-based learning model based on ethnosciences to 28 fifth-grade students at SDN Manyaran 02, Semarang City, in the academic year 2023/2024. The teaching process was conducted offline with face-to-face interaction. The sample in this study was class VA, consisting of 11 male students and 17 female students. The subject taught was light and its properties in science.

Before conducting the teaching process, the students took a pretest using the learning module with the project-based learning model based on ethnosciences. Next, the researcher conducted the teaching in the class using the learning module with the project-based learning model based on ethnosciences as a teaching aid for delivering the material. The students were also given the learning module with the project-based learning model based on ethnosciences to study independently. The students were divided into several groups during the teaching process to facilitate discussion and project implementation. Before starting the project, the students were given problem sources related to Light and its properties concerning wayang (traditional Javanese puppet).

After understanding the given problems, the students were guided to carry out a project to make wayang puppets to demonstrate the properties of Light. The students worked in groups to discuss and complete the student worksheets that had been prepared. After the teaching process was completed, the next day, the students were asked to take a posttest distributed to all students in class VA at SDN Manyaran 02, Semarang City.

The results of the pretest and posttest conducted in the large group trial consisted of testing the critical reasoning skills of fifth-grade students at SDN Manyaran 02. Additionally, there were observation sheets for teamwork before and after using the module. There were also creative observation sheets before using the module and creative product assessment sheets after using the module. A normality test was conducted to determine whether the samples studied were normally distributed. The data used were the pretest and posttest results of the

students in class VA at SDN Manyaran 02. The results of the normality test conducted are presented in Table 9.

Table 9 The Results of The Normality Test

| Dimensions | Shapiro-Wilk | | | Conclusion |
	Statistic	df	Sig.	
Pre-Colaboration	.930	28	.062	Normal
Post-Collaboration	.932	28	.068	Normal
Pre-Critical Reasoning	.936	28	.087	Normal
Post-Critical Reasoning	.941	28	.118	Normal
Pre-Creativity	.960	28	.355	Normal
Post-Creativity	.942	28	.121	Normal

After conducting the normality test, it can be concluded that the data follows a normal distribution. Next, the final data analysis will be conducted using T-Test and N-Gain tests on the pretest and posttest values for each dimension using SPSS 26.

A comparison of mean differences was conducted to determine the results of the average differences between pretest and posttest scores used to test the effectiveness of the learning module with the project-based learning model based on ethnosciences. The comparison of mean differences utilized parametric statistical techniques through the paired sample t-test formula, aided by SPSS version 26, to obtain the results of comparing mean differences between pretest and posttest scores. The results of the comparison of mean differences are presented in Table 10.

Table 10 Results of Mean Difference Test

| Dimensions | Paired Differences | | | | | T | df | Sig. (2-tailed) |
| | Mean | Std. Dev. | Std. Error | 95% | | | | |
				Lower	Upper			
Collaboration	-13.83	4.39	0.83	-15.54	-12.13	-16.65	27	0.000
Critical Reasoning	-9.91	6.95	1.31	-12.60	-7.21	-7.54	27	0.000
Creativity	-17.11	5.81	1.09	-19.36	-14.85	-15.55	27	0.000

Based on Table 10, the results of the paired sample t-test using SPSS version 26 show that the significance value (2-tailed) for each dimension is 0.000. The criteria for the paired sample t-test are that if the significance value (2-tailed) is > 0.005, then there is no significant difference between the pretest and posttest scores in the students' collaboration, critical reasoning, and creativity. The t-test results indicate that the significance value (2-tailed) for each dimension is 0.000, which means < 0.005, indicating a significant difference between the pretest and post-test results.

N-Gain data aims to determine the extent of students' improvement before and after the treatment. The average increase in pretest and posttest scores for each dimension using the learning module with project-based learning based on ethnosciences is presented in Table 11.

Table 11 Results of the N-Gain Test

Dimension	Before	After	Difference	⟨*g*⟩	Criteria
Collaboration	71.13	84.97	13.84	0.92	High
Critical Reasoning	66.42	76.33	9.91	0.41	Medium
Creativity	69.79	86.90	17.11	1.30	High

Evaluation Phase

The evaluation phase is a crucial step in the ADDIE model of development research. During this phase, evaluation and improvements are made based on feedback from expert validators in media and content using a product validation questionnaire. This evaluation phase aims to enhance the developed product based on researcher feedback, ensuring its suitability for use.

CONCLUSION

The research on the development of a learning module using the ethnoscience-based project-based learning model for the science subject of Light and its properties for fifth-grade students at SDN Manyaran 02, Semarang, concludes that this module is student-centered, utilizes the cultural environment as a learning resource, and promotes teamwork, critical reasoning, and creativity. The module was rated "Highly Feasible" by media, content, and language validators with a 100% percentage and by teachers and students through a feedback questionnaire on module usage. The module is also effective, with an increase in students' pretest and posttest results: the dimension of teamwork received an N-Gain score of 0.92 in the "High" category, critical reasoning received an N-Gain score of 0.4 in the "Medium" category, and creativity received an N-Gain score of 1.30 in the "High" category.

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